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सरिये — विशिष्टि
(दूसरा पुनरीक्षण)

High Carbon Steel Wire Rods —
Specification
(Second Revision)

ICS 77.140.65

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FOREWORD

This Indian Standard (Second Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Wrought Steel Products Sectional Committee had been approved by the Metallurgical Engineering Division Council.

This standard was first published in 1975 and revised in 1995. A large quantity of high carbon steel wires is manufactured in India. Some important uses for these wires are prestressed concrete wires, steel spring wires, spoke wires, umbrella rib wires, textile industry wires and wires for general engineering purposes. Since carbon steel wire rods, which is the raw material for these wires, a need was felt to review the standard to ensure that the wire drawing industry receive the requisite quality of raw material. The Committee, therefore, decided to revise it in line with the present practices being followed by the Indian industry.

Important changes made in this revision are as follows:

- a) Steel wire rods designated in various grades as per the chemical compositions;
- b) Provision of ordering steel wire rods according to tensile strength;
- c) Condition of material on delivery modified;
- d) Dimensional tolerances have been modified;
- e) Sampling and criteria for conformity modified;
- f) Surface defects criteria modified;
- g) Limit values for non-metallic inclusions modified; and
- h) Clause on grain size (optional criteria) removed;

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

HIGH CARBON STEEL WIRE RODS — SPECIFICATION

(Second Revision)

1 SCOPE

This standard covers the requirements for high carbon steel wire rods for the manufacture of wires for various purposes.

2 REFERENCES

The standards listed below contain provisions, which through reference in this text constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below:

<i>IS No.</i>	<i>Title</i>
228 (All parts)	Methods for chemical analysis of steels
1608 : 2005	Metallic materials — Tensile testing at ambient temperature (<i>third revision</i>)
1956 (All Parts)	Glossary of terms relating to iron and steel
4163 : 2004	Steel — Determination of content of non-metallic Inclusions — Micrographic method using standard diagrams (<i>third revision</i>)
6396 : 2000	Methods of measuring decarburized depth of steel (<i>second revision</i>)
8910 : 2010	General technical delivery requirements for steel products (<i>first revision</i>)
IS/ISO 16124 : 2004	Steel wire rod — Dimensions and tolerances

3 TERMINOLOGY

For the purpose of this standard, the definitions given in IS 1956 shall apply.

4 SUPPLY OF MATERIAL

General requirements for the supply of material shall be as laid down in IS 8910.

5 GRADES

5.1 Steel wire rods shall be designated in various grades as per the chemical compositions (ladle analysis/billet analysis for continuous cast billets) mentioned in Table 1 or as per tensile strength as mentioned in Table 2. For grades specified by chemical composition if requested by the purchaser at the time of ordering, the supplier shall provide minimum value of tensile strength and for grades specified by tensile strength, if requested by the purchaser at the time of ordering, the supplier shall provide value of chemical composition.

5.2 Various high carbon grades of steel wire rods designated as per tensile strength shall fall within the tensile strength range of 535 MPa to 1 250 MPa. The minimum of the required ultimate tensile strength (UTS) range shall be used as a suffix to 'HCT' for grade designation; for example HCT635, where the required minimum of the UTS is 635 MPa. If alloying/ micro-alloying elements are added intentionally to meet the mechanical properties requirements, the grades will be designated with a suffix indicating their chemical symbol for example HCT535Cr will have minimum tensile strength of 535 MPa and chromium 0.30 maximum.

6 MANUFACTURE

6.1 The steel shall be manufactured by any process of steel making at the discretion of the manufacturer. It may be followed by secondary refining or vacuum degassing. Steel can be cast into ingots or continuously cast into billets/blooms.

6.2 Sufficient discard shall be made from each ingot to ensure freedom from piping, segregation and other harmful defects.

6.3 During the process of manufacture, the material may be chipped, ground, scarfed or otherwise prepared to remove surface imperfections likely to produce defects in rods. Scales on the wire rod shall be controlled by the manufacturer to the minimum.

7 CHEMICAL COMPOSITION

7.1 For grades specified by chemical composition, the ladle analysis of steel when analyzed in accordance with the relevant parts of IS 228 or any other established

Table 1 Chemical Composition
(Clauses 5.1 and 7.2)

Sl No.	Steel Grade	C Percent	Si Percent	Mn Percent	P Percent Max	S Percent Max	Cr Percent Max	Ni Percent Max	Mo Percent Max	Cu Percent Max	Al Percent Max	S+P Max
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
i)	HC38	0.35-0.40	0.10-0.35	0.30-0.90	0.035	0.035	0.15	0.20	0.05	0.25	0.04	0.06
ii)	HC42	0.40-0.45	0.10-0.35	0.30-0.90	0.035	0.035	0.15	0.20	0.05	0.25	0.04	0.06
iii)	HC46	0.43-0.48	0.10-0.35	0.30-0.90	0.035	0.035	0.15	0.20	0.05	0.25	0.04	0.06
iv)	HC48	0.45-0.50	0.10-0.35	0.30-0.90	0.035	0.035	0.15	0.20	0.05	0.25	0.04	0.06
v)	HC50	0.48-0.53	0.10-0.35	0.30-0.90	0.035	0.035	0.15	0.20	0.05	0.25	0.04	0.06
vi)	HC52	0.50-0.55	0.10-0.35	0.30-0.90	0.035	0.035	0.15	0.20	0.05	0.25	0.04	0.06
vii)	HC56	0.53-0.58	0.10-0.35	0.30-0.90	0.035	0.035	0.15	0.20	0.05	0.25	0.04	0.06
viii)	HC58	0.55-0.60	0.10-0.35	0.30-0.90	0.035	0.035	0.15	0.20	0.05	0.25	0.04	0.06
ix)	HC60	0.58-0.63	0.10-0.35	0.30-0.90	0.035	0.035	0.15	0.20	0.05	0.25	0.04	0.06
x)	HC62	0.60-0.65	0.10-0.35	0.30-0.90	0.035	0.035	0.15	0.20	0.05	0.25	0.04	0.06
xi)	HC66	0.63-0.68	0.10-0.35	0.30-0.90	0.035	0.035	0.15	0.20	0.05	0.25	0.04	0.06
xii)	HC68	0.65-0.70	0.10-0.35	0.30-0.90	0.035	0.035	0.15	0.20	0.05	0.25	0.04	0.06
xiii)	HC70	0.68-0.73	0.10-0.35	0.30-0.90	0.035	0.035	0.15	0.20	0.05	0.25	0.04	0.06
xiv)	HC72	0.70-0.75	0.10-0.35	0.30-0.90	0.035	0.035	0.15	0.20	0.05	0.25	0.04	0.06
xv)	HC76	0.73-0.78	0.10-0.35	0.30-0.90	0.035	0.035	0.15	0.20	0.05	0.25	0.04	0.06
xvi)	HC78	0.75-0.80	0.10-0.35	0.30-0.90	0.035	0.035	0.15	0.20	0.05	0.25	0.04	0.06
xvii)	HC80	0.78-0.83	0.10-0.35	0.30-0.90	0.035	0.035	0.15	0.20	0.05	0.25	0.04	0.06
xviii)	HC82	0.80-0.85	0.10-0.35	0.30-0.90	0.035	0.035	0.15	0.20	0.05	0.25	0.04	0.06
xix)	HC86	0.83-0.88	0.10-0.35	0.30-0.90	0.035	0.035	0.15	0.20	0.05	0.25	0.04	0.06
xx)	HC88	0.85-0.90	0.10-0.35	0.30-0.90	0.035	0.035	0.15	0.20	0.05	0.25	0.04	0.06

NOTES

1 If Cr, B, Nb, V, Ti are added intentionally, the grades may contain Cr up to 0.30 percent and B up to 8 ppm as per mechanical property required in wire rods. However, the total percentage of Cr and micro alloy elements (Nb, V, Ti) individually or in combination should not exceed 0.30 percent.

2 Steel may be supplied as grade A and grade B depending upon Mn content 0.30-0.60 percent and 0.60-0.90 percent in grades respectively for example the grade will be designated as HC70A or HC70B depending upon Mn content 0.30-0.60 percent or 0.60-0.90 percent in HC70 grades respectively.

3 The grade containing Cr > 0.15% would be designated with the suffix indicating the chemical symbol, for example HC70ACr will have chemical composition of HC70A and Cr individually or in combination with other Microalloying elements should not exceed 0.30 percent.

4 Nitrogen content of steel shall not exceed 0.012 percent, which shall be ensured by the manufacturer by occasional check analysis.

5 Stricter specification for nitrogen, phosphorus and sulphur may be mutually agreed between the manufacturer and the purchaser.

6 Tramp elements [Cr, Ni, Mo, Cu] individually or in combination can be stricter than the values mentioned in Table 1, may be mutually agreed upon between the manufacturer and the purchaser at the time of ordering.

instrumental/chemical method shall be as given in Table 1. In case of dispute the procedure given in relevant parts of IS 228 shall be the referee method. However, where the method is not given in IS 228 or its relevant parts, the referee method shall be as agreed to between the purchaser and the manufacturer.

7.2 Permissible limits of variation in case of product analysis from the limits specified in Table 1 shall be as given in Table 3.

Table 2 Permissible Variation in Mechanical Properties
(Clause 5.2)

Sl No.	Steel Grade	UTS Mpa	Percent RA Minimum
(1)	(2)	(3)	(4)
i)	HCT535 to HCT840	0, +200	35
ii)	> HCT840 to HCT1030	0, +200	30
iii)	> HCT1030 to HCT1250	0, +300	30

Table 3 Permissible Variation for Product Analysis of Carbon Steel
(Clause 7.2)

Sl No.	Constituent	Variation Over the Specified Maximum or Under the Minimum Limits, Percent <i>Max</i>
(1)	(2)	(3)
i)	Carbon < 0.5	0.03
ii)	Carbon ≥ 0.5	0.04
iii)	Manganese	0.05
iv)	Sulphur	0.005
v)	Phosphorus	0.005
vi)	Silicon	0.03
vii)	Copper	0.03
viii)	Nickel	0.03
ix)	Chromium	0.03

8 CONDITION OF MATERIAL ON DELIVERY

Wire rods shall be delivered in as-rolled condition after suitable controlled cooling.

The following information shall be supplied by the purchaser at the time of enquiry and order :

- Quantity to be delivered;
- Cross-section and product type (round wire rod, square wire rod, hexagonal wire rod, etc);
- Nominal dimension of the wire rod;
- Steel grade designation as per chemical composition or tensile strength mentioned in this specification;
- Minimum weight of coils;
- Depth of decarburization; if nothing is mentioned in the order, Type Y of Table 5 will be delivered. In case Type X is opted by the purchaser, the grade would be designated with suffix 'X' for example HC70AX indicates chemical composition of HC70A and depth of decarburization of Type X of Table 5; and
- If specifically agreed to between the purchaser and the manufacturer/supplier, the following metallurgical tests may be carried out and reported
 - Non-metallic inclusions as per 14.
 - Microstructure as per 15.
 - Axial segregation as per 16.

9 DIMENSIONAL TOLERANCE

The level of tolerances and out of roundness of the round wire rod shall be in accordance with Table 2 level T1 of IS/ISO 16124. Stricter levels of tolerance and/or out of round may be mutually agreed upon between

the manufacturer and the purchaser at the time of ordering. For other sections like square, hexagonal, rectangular shapes, level of tolerances of the wire rod shall be in accordance with relevant tables of IS/ISO 16124.

10 MECHANICAL PROPERTIES

For grades specified by tensile strength, the tensile test of steel wire rod shall be conducted in accordance with IS 1608.

The ultimate tensile strength of the wire rod shall fall within the limits of permissible variation given in Table 2 for the designated strength level. The minimum requirements of percent RA (percentage reduction of area) shall be determined in accordance with IS 1608 and also be indicated as given in Table 2 for the designated strength level.

11 SAMPLING AND CRITERIA FOR CONFORMITY

The sample is composed of wire rod of the same cross-sectional dimension, originating from the same heat, and rolled in the same continuous lot. For special application wire rod, higher frequency of sampling may be agreed between the manufacturer and the purchaser. Unless otherwise agreed, the extent of sampling to be done for meeting these requirements shall be as per Table 4.

12 SURFACE DEFECTS

The finished wire rod shall be cleanly rolled to the dimensions, sections and masses specified. The finished material shall be reasonably free from surface defects like fin, seam, dent, crack, lap, edge, guide mark, scratch, etc. Wire rod coil having any of such surface defects shall be separated by the manufacturer during inspection and shall be segregated after declaring them as defective. In case of decarburized surface defects, the depth of defect shall be measured inclusive of decarburization.

13 DECARBURIZATION TEST

A cross-section of the wire rod (transverse) shall be cut and mounted on rounded plastic or alternative material for preparation of the section. After polishing and etching by suitable etchant, the section shall be examined under microscope at 100X magnification. In case a hardness profile is taken to determine the depth of decarburization, the same shall be deemed to commence from the location where the hardness drops to 75 percent of the base value. Number of samples as mentioned in Table 4 should be analyzed. The maximum limits of partial decarburization shall be as indicated in Table 5.

Table 4 Acceptance Unit and Number of Samples and Test Pieces
(Clause 11)

Sl No.	Type of Requirement	Number of Samples or Test Pieces
(1)	(2)	(3)
i)	Tensile strength	1 per 40 tonne with a minimum of 3 per heat
ii)	Permissible depth of decarburization	2 per heat minimum while rolled in the same continuous lot
iii)	Non-metallic inclusions (see 8)	2 per heat minimum while rolled in the same continuous lot
iv)	Microstructure (see 8)	2 per heat minimum while rolled in the same continuous lot
v)	Axial/Core segregation (see 8)	2 per heat minimum

Table 5 Maximum Limits of Partial Decarburization
(Clause 13)

Sl No.	Type	Limit of Maximum Value of Partial Decarburization as a Percentage of Diameter/Diagonal
(1)	(2)	(3)
i)	X	1.0
ii)	Y	2.0

NOTE — In measuring the depth of decarburization in addition to the above a reference may also be made to IS 6396.

14 NON-METALLIC INCLUSIONS

14.1 If specifically agreed to between the purchaser and the manufacturer/supplier. Non-metallic inclusion test may be carried out and reported.

14.2 Non-metallic inclusion when tested according to IS 4163 (method A) shall not exceed the values given in Table 6.

Table 6 Limit Values for Non-Metallic Inclusions
(Clause 14.2)

Sl No.	Inclusion Type ¹⁾	Thin		Thick	
		Worst	Mean	Worst	Mean
(1)	(2)	(3)	(4)	(5)	(6)
i)	A	4	2	3	1.5
ii)	B	3	2	2	1.0
iii)	C	4	2	3	1.5
iv)	D	3	2	2	1.0

¹⁾ Inclusion types according to IS 4163.

NOTE — As the applications are quite varied, stringent inclusion ratings other than those specified may be mutually agreed to between the manufacturer and the purchaser.

15 MICROSTRUCTURE

If specifically agreed to between the purchaser and the manufacturer/supplier, the limit of percentage of resolvable pearlite may be reported. Controlled cooled material shall have a fine pearlitic structure, the maximum limit of percentage resolvable pearlite at 500X magnification is given in Table 7.

Table 7 Maximum Resolvable Pearlite at 500X Magnifications Linear Intercept Method
(Clause 15)

Sl No.	Diameter mm	Resolvable Pearlite, Percent Max
(1)	(2)	(3)
i)	Up to 8.00	15
ii)	Over 8.00	20

NOTE — Alternatively, stricter limit of percentage of resolvable pearlite may be mutually agreed upon between the manufacturer and the purchaser.

16 AXIAL SEGREGATION

Reporting of axial segregation is optional, the method of inspecting axial segregation and the assessment criteria shall be agreed upon at the time of ordering.

17 PACKING

Each coil of wire rod shall be bound and fastened compactly.

18 MARKING

18.1 Each coil of wire rod shall carry a tag which shall be legibly marked with the cast number, grade, size of the wire rod and manufacturer's name or trade-mark. If mutually agreed, weight of coils will be included in the tag.

18.2 BIS Certification Marking

The material may also be marked with the Standard Mark.

18.2.1 The use of the Standard Mark is governed by the provisions of *Bureau of Indian Standard Act, 1986* and the Rules and Regulations made thereunder. The details of conditions under which the license for the use of Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

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Amendments Issued Since Publication

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